Chapter 7

Geographical Simulation Analysis

June 2016

This chapter should be cited as

ERIA Study Team (2016), 'Geographical Simulation Analysis', in Nishimura, H., F. Kimura, M. Ambashi, and S. Keola (eds.), *Lao PDR at the Crossroads: Industrial Development Strategies 2016-2030*. ERIA Research Project Report 2015-2, Jakarta: ERIA, pp.225-239.

Chapter 7

Geographical Simulation Analysis

Introduction

Insufficient infrastructure and difficult landscape are major obstacles that have hindered industrialisation in Lao PDR. In many developed and developing countries, industrial estates including special economic zones (SEZs) are effectively used to kick-start industrialisation through the concentration of limited resources (Bredo, 1960; Young, 1992; Catin, 2005). In this chapter it is argued that development of industrial estates (including SEZs) is a potential solution to the lack of industrialisation in Lao PDR.

The aim of this chapter is twofold. First, it attempts to quantify the effects of several official SEZs developed in Lao PDR. (SEZs in Lao PDR refer to both special and specific economic zones.) Currently, there are more than 10 approved special and specific economic zones in the capital city and major provinces, which are at various stages of planning and investment. This chapter takes into account several manufacturing related SEZs in Vientiane Capital, Savannakhet, Champasak, and Thakek province. Although SEZ development has repeatedly proved to be an effective way of generating high growth, its effect is often limited to local areas and entails regional disparity (Krongkaew, 1995; Jones and Cheng, 2003). Hence, additional policy measures to address regional disparity are necessary. Since the 1990s, the facilitation of cross-border economic activities has contributed significantly to economic growth in Lao PDR. Benefits from expanding trade with Thailand have been large mainly because Lao PDR's population is concentrated on major plains along Western border areas of Thailand. On the other hand, trade with Viet Nam and China including transit trade has been picking up rapidly since the beginning of 2000s, but the most rural border areas along the borders with these countries are still mostly the poorest regions in Lao PDR.

The second goal of this chapter is to estimate by simulation the effect of reduced border barriers, especially in the East (Viet Nam) and to the North (China), as well as the effect of the reduction in non-tariff barriers (NTBs) on the whole country.

The rest of this chapter is structured as follows. Section 7.1 summarises historical/theoretical backgrounds, basic structures, the baseline scenario, and the simulation procedure of the Institute of Developing Economies – Geographical Simulation Model (IDE–GSM). Section 7.2 describes simulated scenarios and results. Finally, Section 7.3 concludes with policy recommendations.

7.1. The IDE Geographical Simulation Model (IDE/ERIA–GSM)

7.1.1. What is IDE/ERIA–GSM?

Since 2007, the Institute of Developing Economies–Japan External Trade Organization (IDE-JETRO) has been developing IDE–GSM. The theoretical foundation of the IDE/ERIA–GSM, which is co-developed with ERIA, follows 'New Economic Geography' (NEG), in particular, Puga and Venables (1996) who capture the characteristics of multi-sector and country general equilibrium.

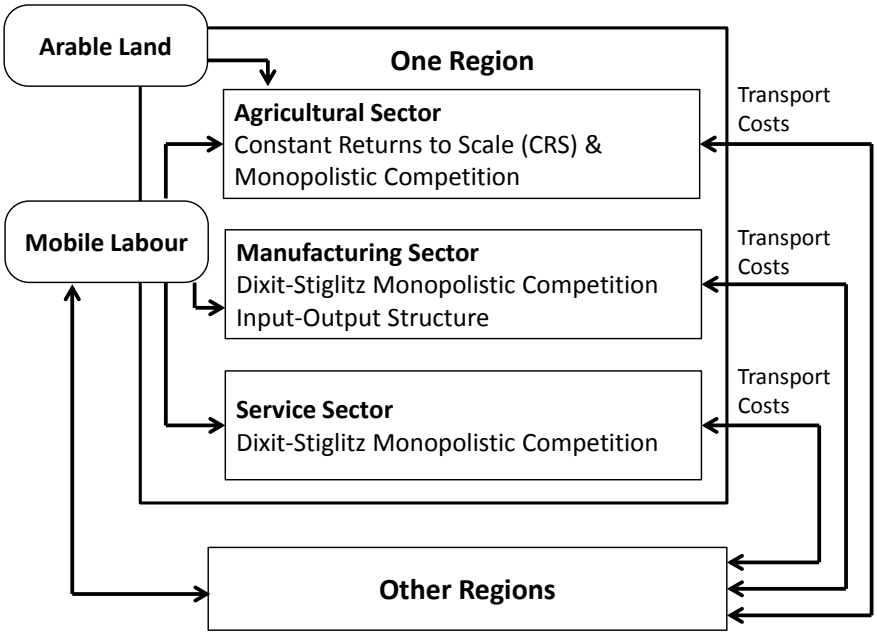
The IDE/ERIA–GSM features agriculture, five manufacturing sectors (automotive, electric and electronics, textile and garment, food processing, and other manufacturing) and the services sector. The model allows workers to move within countries and between sectors. A notable difference of the IDE/ERIA–GSM from that of Puga and Venables (1996) lies in the specification of the agricultural sector. The IDE/ERIA–GSM explicitly incorporates land size in its production and keeps its technology as constant returns to scale.[30] This model incorporates into the simulations the type of physical or institutional integration that will favourably or adversely affect regions of interest at the sub-national level. It also incorporates the

[30] For further details of IDE–ERIA GSM, see Kumagai et al. (2015).

impact of policy measures to facilitate international transactions on the magnitude and location of trade traffic. These enable us to identify potential bottlenecks and the way to reap the full benefits of economic integration. This chapter provides a customised version of the model that divides the country into 139 districts in contrast to the original version that included only 17 provinces. Furthermore, the model expands the basic model of NEG by incorporating numerous realistic features, such as multiple industrial sectors with intermediate inputs, a multimodal transport selection model, and the existence of tariff barriers and NTBs in international trade.

The basic structure of IDE/ERIA–GSM is depicted in Figure 7.1. Each region possesses seven economic sectors (agriculture, five manufacturing sectors, and the services sector). Regions in this particular setting of IDE/ERIA–GSM refer to districts within Lao PDR, but not provinces in neighbouring countries. Labour can move between industries within countries, as well as across national borders.

Figure 7.1. Basic Structure of the IDE/ERIA–GSM Geographical Simulation Model

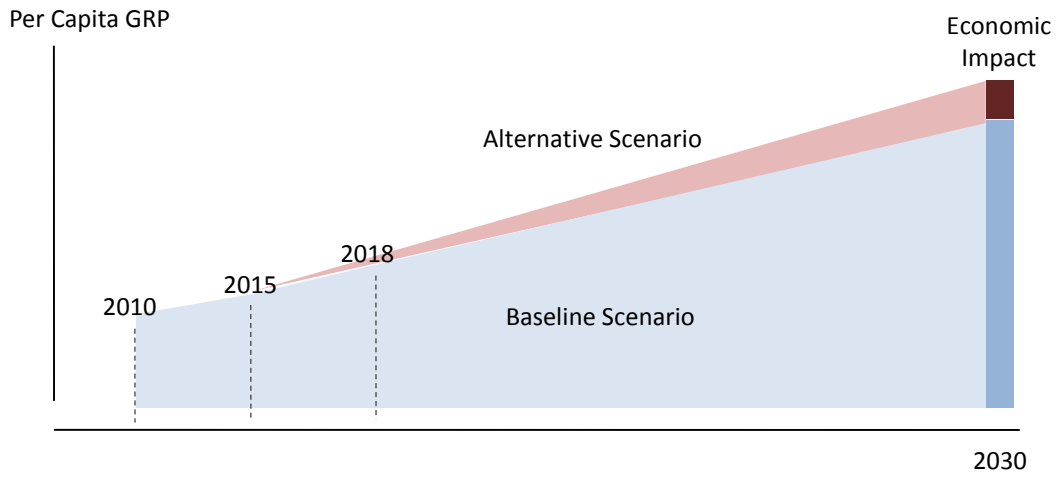


Source: IDE/ERIA–GSM Team.

7.1.2. Base Line Scenario and Alternative Scenarios

We consider the differences of gross regional product (GRP) between the baseline scenario and alternative scenarios (Figure 7.2) to calculate the economic impact of development of various SEZs and border facilitation measures with neighbouring countries. The baseline scenario assumes that minimal SEZ development and border facilitation measures are performed after 2015. The alternative scenario assumes that specific policy measures are taken in 2015 and they will continue beyond 2015. We compare the per capita GRP between these two scenarios in 2030. If the per capita GRP of a region under the scenario with specific scenarios is higher (lower) than that under the baseline scenario, we regard this surplus (deficit) as a positive (negative) economic impact of development of SEZs and border facilitation measures.

Figure 7.2. Image Diagram: Difference between the Baseline and Alternative Scenarios



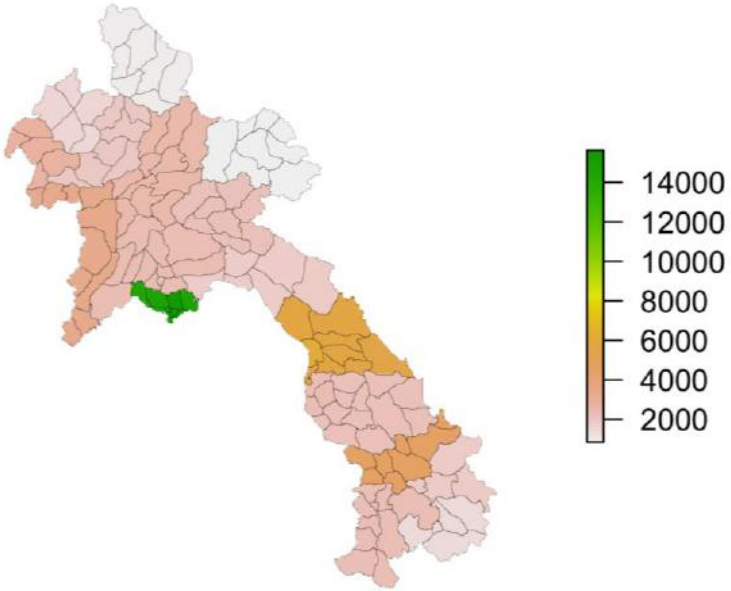
GRP = gross regional product.
Source: IDE/ERIA–GSM Team.

Conventionally, the IDE/ERIA–GSM evaluates alternative scenarios through comparison of gross domestic product (GDP) or GRP, but in this particular study we focus instead on per capita GRP to reflect its importance which official plans stress. The ultimate goal of official development plans in Lao PDR has recently been to increase per capita income and/or value-added at the national level. For example, the

10 Year Development Strategy aims to double per capita GDP between 2015 and 2020. Vision 2030, the longer-term development plan, attempts to quadruple per capita GDP in 2015 by 2030. With this in mind, by using a geographic model with finer regional data, this chapter looks at impacts on per capita GRP by each of Lao PDR's 139 districts.

Our baseline scenario predicts a national per capita GDP of US$4,423.52. However, at a district level, per capita GRP varies from about US$1,000 in most Northern and Southern districts in border areas with Viet Nam and China to more than US$14,000 in Vientiane Capital. This is the baseline case scenario, in which none of the SEZ developments and border facilitations have materialised. It is noteworthy that, in a broader sense, this baseline case includes partially materialised plans, i.e. SEZ development plans that fail to attract investors or border facilitation measures that fail to be properly implemented. It does not take into account major energy and resource development projects, which, if implemented, will almost certainly push up GDP and GRP through capital stock accumulations.

Figure 7.3. Per Capita Income by District in 2030 in the Base Line Scenario



Source: IDE/ERIA–GSM Team.

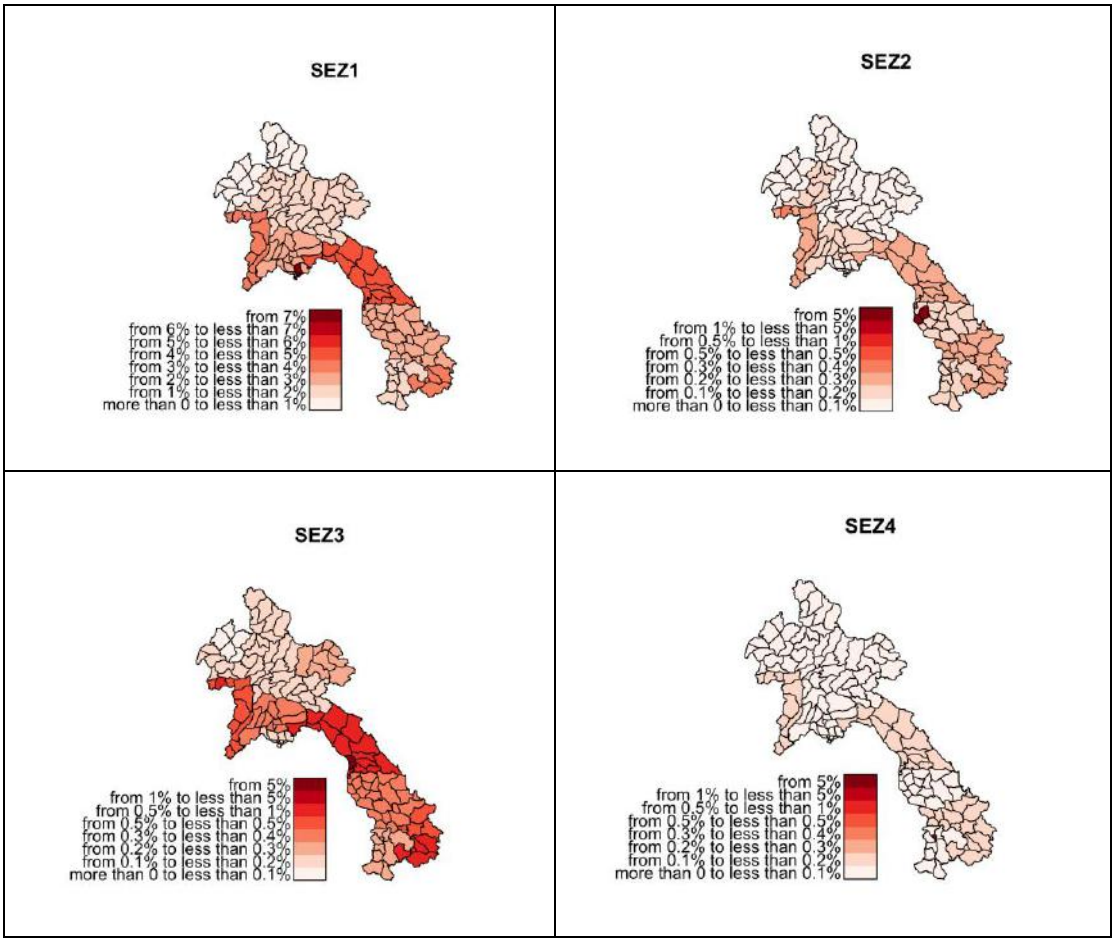
7.2. Scenarios and Results

We conduct a simulation analysis of three major scenarios – (i) development of SEZs, (ii) border facilitation in association with each neighbouring countries, and (iii) reduction of NTBs in the whole country.

7.2.1. Special Economic Zone Developments: Scenario SEZ1 to SEZ5

Scenarios SEZ1 to SEZ5 indicate development of SEZs in (1) Vientiane Capital, (2) Savanakhet, (3) Champasak, (4) Khammouan, and (5) All of (1) to (4), respectively. In all scenarios, we predict a productivity increase for districts that have SEZs. The results of each SEZ1 to SEZ4 are shown in Figure 7.4.

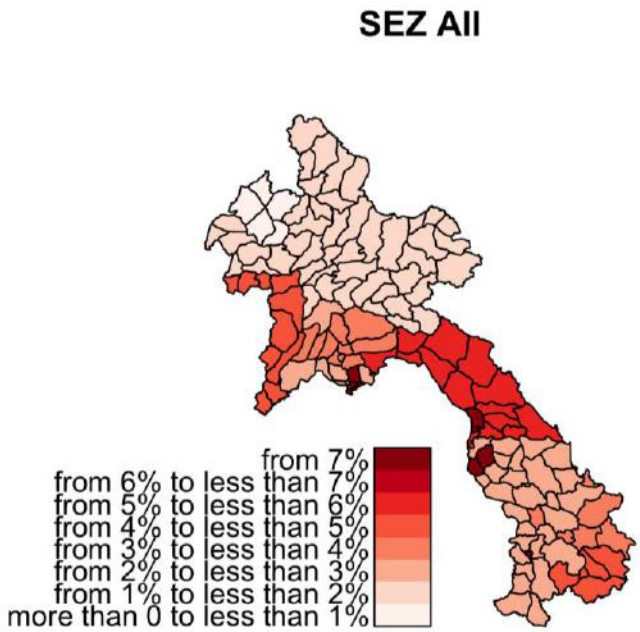
Figure 7.4. Scenarios SEZ1 to SEZ4 (2030)



SEZ = special and specific economic zones.
Source: IDE/ERIA–GSM Team.

Except for (1) Vientiane Capital, SEZ development pushes up per capita GRP in districts, where SEZs are located by about 4 percent in 2030 compared with the baseline scenario. On the other hand, in Vientiane Capital, the impacts increased per capita GRP about by 8 percent, i.e. by twice as much. SEZ development in Vientiane Capital also generates positive impacts on its neighbouring regions; a result that cannot be seen in other cases. This is for two reasons: First, regions surrounding the capital city have a higher manufacturing industry share from the outset, making it easier for them to enjoy positive impacts from SEZ developments in the capital city. Second, the capital city is connected with better roads to surrounding regions compared with SEZs located in other provinces.

Figure 7.5. Scenarios SEZ All (2030)



SEZ = special and specific economic zones; GRP = gross regional product.
Source: IDE/ERIA–GSM Team.

The degree of benefits from the development of all SEZs is presented in Figure 7.5. As expected, if all SEZs are developed, the benefits exceed those of individual cases. Per capita GRP increases of more than 10 percent can be observed in several districts. Moreover, because of the geographical advantage, the SEZ in (4) Khammoun, located

between the Vientiane Capital and Savannakhet, generates larger positive effects than other cases from (1) to (3).

The 10 percent increase of per capita GRP is actually very large when compared with conventional policy measures in official development plans. Traditionally, official development plans in Lao PDR would, first, set the overall growth target of GDP and per capita GDP. Then necessary investment, from all sources, would be computed based on Incremental Capital–Output Ratio (ICOR) in Lao PDR. Given the early stage of economic development, where infrastructure is often underdeveloped or lacking, it is not a surprise that investment plays such an important role. In general, the Government of Lao PDR would expect (i.e. plan) to invest about 30 percent of GDP to achieve about 7 percent growth. As Lao PDR's GDP in 2015 is estimated at US$13 billion, an annual investment of around US$5 billion would be necessary according to a simple calculation. A decent SEZ would generally cost about US$100 million to be built from scratch and, once constructed, can last for decades, producing significant economic impacts, unlike an investment growth model which requires continuous investment. Despite maintenance costs in addition to construction costs, the impacts of SEZs on per capita GRP or GDP by regions are in fact much higher if these simulation results are taken at face value.

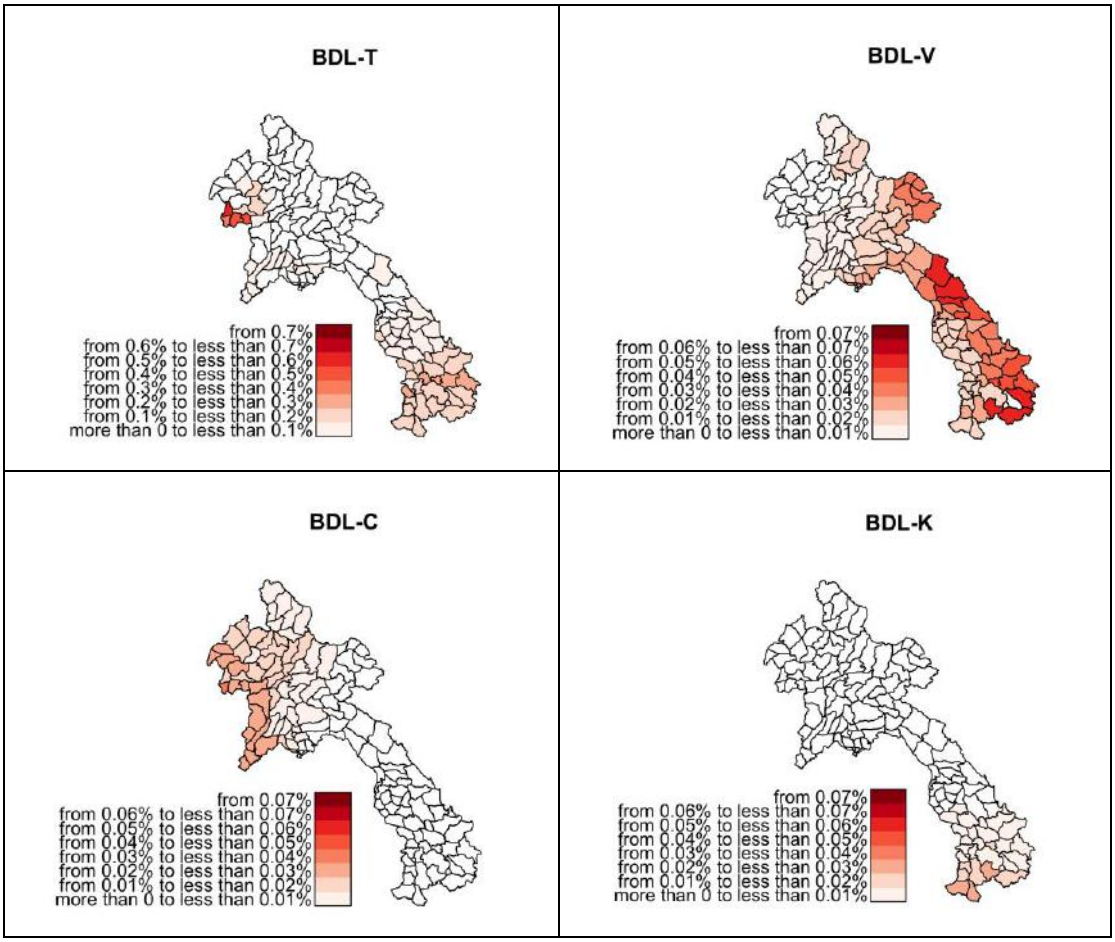
7.2.2. Border facilitations: Scenario BDL–T, BDL–V, BDL–C, and BDL–K

Scenarios of facilitation of borders with neighbouring countries include (1) BDL–T (Thailand), (2) BDL–V (Viet Nam), (3) BDL–C (China), (4) BDL–K (Cambodia)[31], and (5) All of (1) to (4). In all scenarios, we assume a reduction by half in time and money cost for transportation of goods across the borders. The results of (1)–(4) are shown in Figure 7.6. With regard to the magnitude of the impacts, the highest is for the case of (1) facilitation of the border with Thailand. As one may expect, such impacts can be actually observed in rural border areas where border facilitation practices have been

[31] BDL-T, BDL-V, BDL-C, and BDL-K stand for Border of Lao PDR with Thailand, Viet Nam, China, and Cambodia, respectively.

implemented. There is generally a concern that freer borders could result in the economic decline of border areas, but our simulation results show that they can be effective measures to help address development gaps in rural border regions. Concretely, border facilitation with Viet Nam has increased per capita GRP of the rural border areas bordering Viet Nam, whereas border facilitation with China has expanded positive economic impacts southwards through the North–South Economic Corridors.

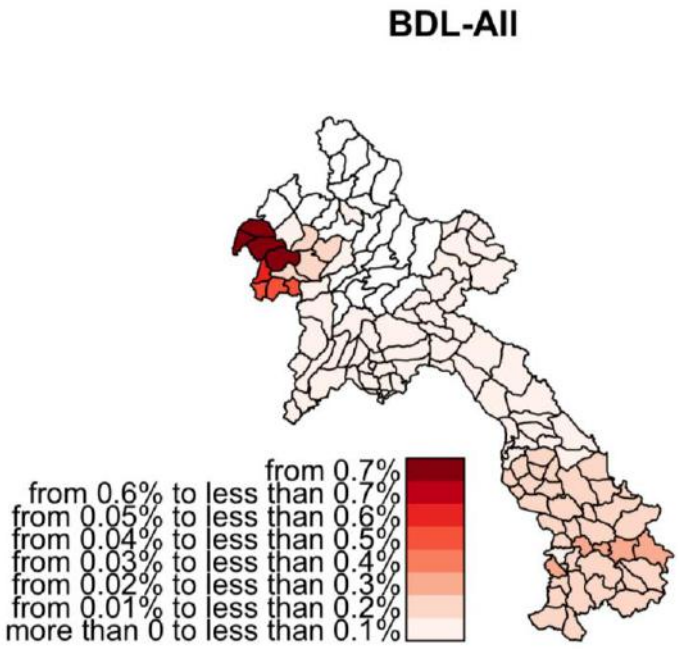
Figure 7.6. Scenarios BDL (2030)



BDL = border of Lao PDR; GRP = gross regional product.
Source: IDE/ERIA–GSM Team.

As is the case with SEZ development, the economic benefits of all border facilitations are greater than the sum of individual cases. One surprising result is that the impact on Bokeo, which borders three countries – Thailand, China, and Myanmar – is the highest. The scenario concerning border facilitation with Myanmar is skipped in this analysis for reasons, such as the lack of regional data in Myanmar, but this scenario could be also expected to have a high impact.

Figure 7.7. Scenarios All Borders (2030)



GRP = gross regional product.
Source: IDE/ERIA–GSM Team.

The magnitude of impact on per capita GRP through border facilitation seems small when compared with SEZ development. However, border facilitation, in this particular simulation, refer to merely reducing the time it takes to cross borders. This can normally be done without additional financial costs. The time it takes to cross the majority of border posts in Lao PDR is in the order of hours. And if one takes into account the times border gates are closed and the cases where goods are required to be stored in bonded warehouses, the waiting time can increase to the order of days and weeks. In reality, border costs are not limited to time costs; they are also money

costs. In short, the room for improvement – therefore, positive economic impacts of border facilitation – remains large.

7.2.3. Reduction of NTBs

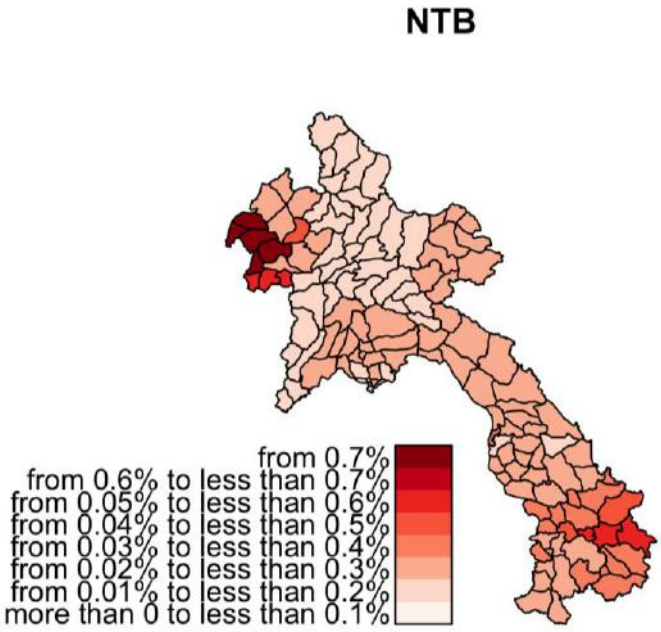
In this scenario, it is assumed that Lao PDR will lower the level of its services barriers from 2016 to 2025 to the level of Cambodia's barriers. NTBs for manufacturing goods will gradually decrease as the efficiency of the services sector increases, and hence a positive impact of reducing NTBs is also expected for manufacturing goods. The level of Cambodia's barriers is 46.0 percent of that of Lao PDR. Thus, we are supposed to reduce Lao PDR's barriers by 54.0 percent in 10 years; that is, from 321.1 to 147.8 in numerical terms.

In addition to the reduction in barriers of the services sector, it is also assumed that we reduce the NTBs for the manufacturing sector, taking into account that services are used as an input for the manufacturing sector. As a proxy, we take the ratio of the domestic service input to the output value for each industry from the input–output (IO) matrix of Thailand included in the ASIA Input–Output Matrix 2005, which is published by IDE–JETRO. The specific values are 0.104 for the automotive industry, 0.107 for the electronics and electrical appliances (E&E) industry, 0.172 for the textile/garment industry, 0.125 for the food processing industry, and 0.131 for the other manufacturing industries. In this simulation analysis, the NTBs for the automotive industry in Lao PDR are reduced by 5.6 percent (=0.104 × 0.54) over 10 years.

The result of a NTBs reduction for the whole country is depicted in Figure 7.8. It has a slightly higher impact than the facilitations of all borders.

The simulated result for all alternative scenarios is presented in Figure 7.9. As can be seen, the highest impacts come from development of SEZs, followed by reduced NTBs (for the whole country), and very closely followed by facilitating all borders.

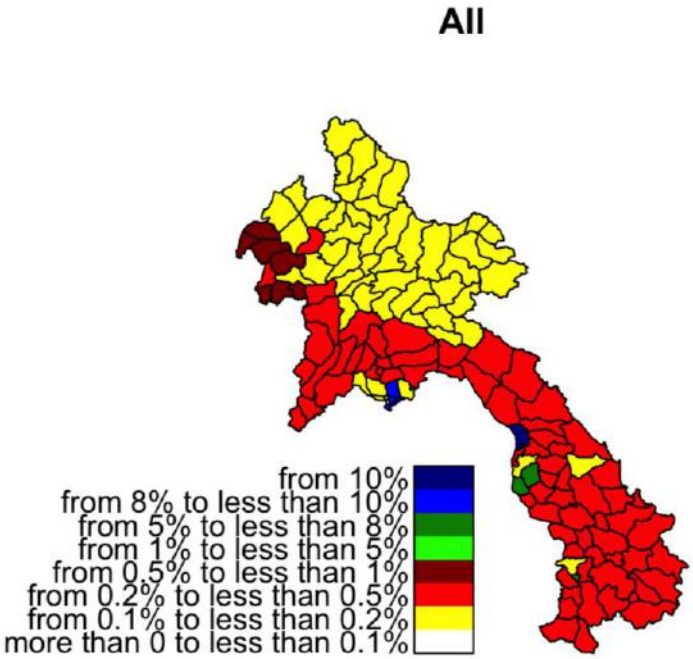
Figure 7.8. Scenarios NTB Reduction (2030)



NTB = non-tariff barrier.
Source: IDE/ERIA–GSM Team.

7.2.4. All Alternative Scenarios

Figure 7.9. All Alternative Scenarios (2030)



GRP = gross regional product.
Source: IDE/ERIA–GSM Team.

7.3. Conclusions and Policy Recommendations

Our simulation analyses revealed that the SEZ developments, NTB reductions, and border facilitations will generate lasting positive economic impacts on Lao PDR, both at the district and national levels. We can derive some policy recommendations from the three different scenarios explored in this study.

First, the development of SEZs generates the highest impact on per capita GRP at the district, provincial, and national levels. Whether these positive impacts spread to neighbouring regions depends on several factors such as industrial structures of surrounding regions and the strength of connectivity to districts where SEZs are developed. To make the most of benefits from SEZ development, we therefore recommend, as discussed in previous chapters, that it should be carried out in conjunction with industrial promotion policies and the improvement of connectivity to surrounding regions.

Second, most urban areas in Lao PDR border with Thailand, and per capita GRP in those areas is usually higher than in other parts of the country. Based on the simulation analysis of the effects of border facilitation, we find that simple measures, such as reducing time costs of goods transported across borders, can increase per capita GRP in rural border areas, especially those bordering Viet Nam, China, and Cambodia. The impacts of border facilitation are lower than those of SEZ development. However, time and money costs incurred for cross-border trade in Lao PDR are still very high at most border crossings, meaning, there is a lot of room for improvement. In other words, greater benefits may be derived from border facilitation measures. We recommend that the government make the greatest use of border facilitation measures to reduce regional disparity, which is also the most important and pressing development issue in Lao PDR.

Third, we found that reduction of NTBs at the national level can also generate higher per capita GRP. Although quantification of NTBs is difficult, there are reasons to believe that the room for improvement is still quite large. Concretely, we recommend services liberalisation in various sectors, such as the wholesale and retail sectors, as it creates higher economic growth. In particular, services related to the manufacturing sector, such as logistics, finance, and professional services, should be designed to reduce the barriers in the manufacturing sector and could achieve higher economic growth.

Finally, the economic impact can be amplified through combinations of many development projects, from SEZ developments, to border facilitation measures, and the reduction of NTBs. We see that synergised effects are always greater than the benefits from individual projects or measures. Careful planning of them is required to achieve higher economic growth, balanced economic growth among its regions, and balanced growth among its industries, to ensure robust economic growth throughout Lao PDR.

References

Bredo, W. (1960), *Industrial Estates: Tool for Industrialization*. New York, NY: Free Press.

Catin, M., X. Luo, and C. van Huffel (2005), Openness, Industrialization and Geographic Concentration of Activities in China. *World Bank Policy Research Working Paper*, No. 3706, Washington, DC: The World Bank.

Jones, D.C. and L. Cheng (2003), 'Growth and Regional Inequality in China during the Reform Era', *China Economic Review*, 14(2), pp.186–200.

Krongkaew, M. (ed.), (1995), *Thailand's Industrialization and its Consequences*. London: MacMillan Press Ltd.

Kumagai, S., K. Hayakawa, I. Isono, S. Keola, and K. Tsubota (2013), 'Geographical Simulation Analysis for Logistics Enhancement in Asia', *Economic Modelling*, 34, pp.145–53.

Kumagai, S., I. Isono, T. Gokan, K. Hayakawa, K. Tsubota, and S. Keola (2015), 'Geographical Simulation Analysis by IDE–GSM' in *China (Shanghai) Pilot Free Trade Zone and the Future of Asia*, Joint Research: IDE–JETRO and Shanghai Academy of Social Sciences.

Puga, D. and A.J. Venables (1996), 'The Spread of Industry: Spatial Agglomeration in Economic Development', *Journal of the Japanese and International Economies*, 10 (4), pp.440-464

Young, A. (1992). 'A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong and Singapore', in *NBER Macroeconomics Annual 1992*, Volume 7, pp.13–64, Cambridge, MA: MIT Press.